EPA

Gold King Mine Acid Mine Drainage Release – Analysis of Fate and Transport of Metals in the Animas and San Juan Rivers

Water Quality Since the Release Event

August 2015 to November 2016

Gold King Team
National Exposure Research Lab/ORD
November 28 2016

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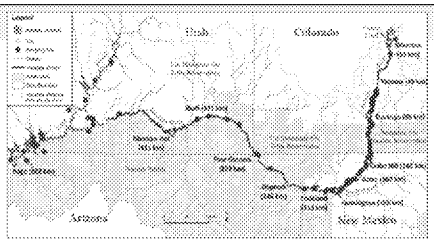
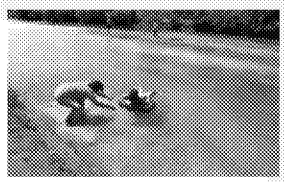
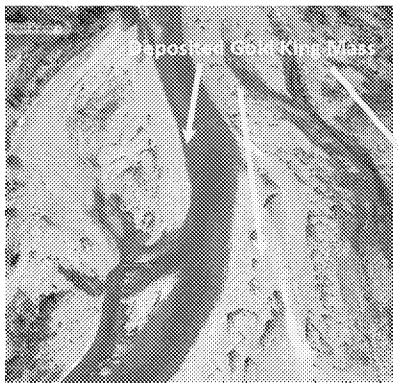
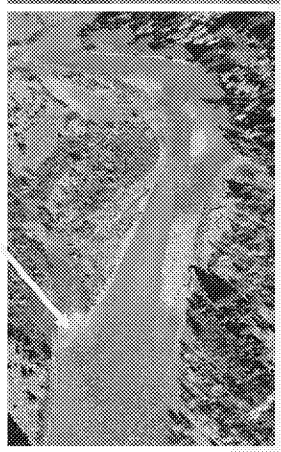
Fate of the Gold King Mine released metals

- **Approximately 500,000 kg delivered from mine to Animas River at Silverton**
  - 1% from within mine
  - 99% from waste pile outside
- **90% of mass deposited in the Animas River** (most between Silverton and Durango CO)
- **5% deposited in the San Juan River** (distributed over 250 km)
- **5% to Lake Powell**









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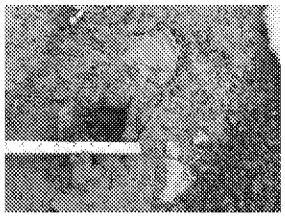
Gold King Effects Continued After the Plume Passed

CURRENT QUESTIONS:

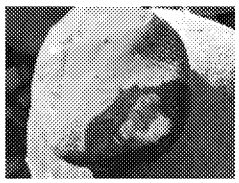
- **What were the Gold King effects on water quality after the event?**
- **Has water quality returned to pre-event conditions?**
- **Was there be a second wave of contamination during 2016 snowmelt when high flows could mobilize deposits?**
- **Can we recognize the Gold King influence given the pre-existing contamination from historic mining?**

What Was Left Behind

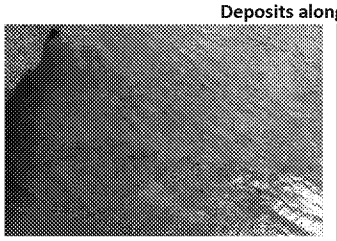
Sludge-like material

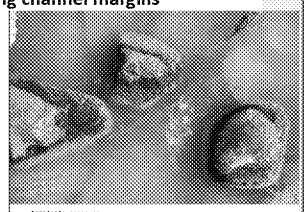


Colloids (Paint-like)



Deposits along channel margins





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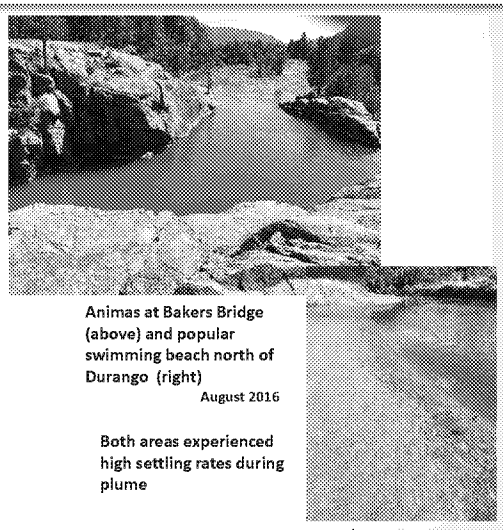
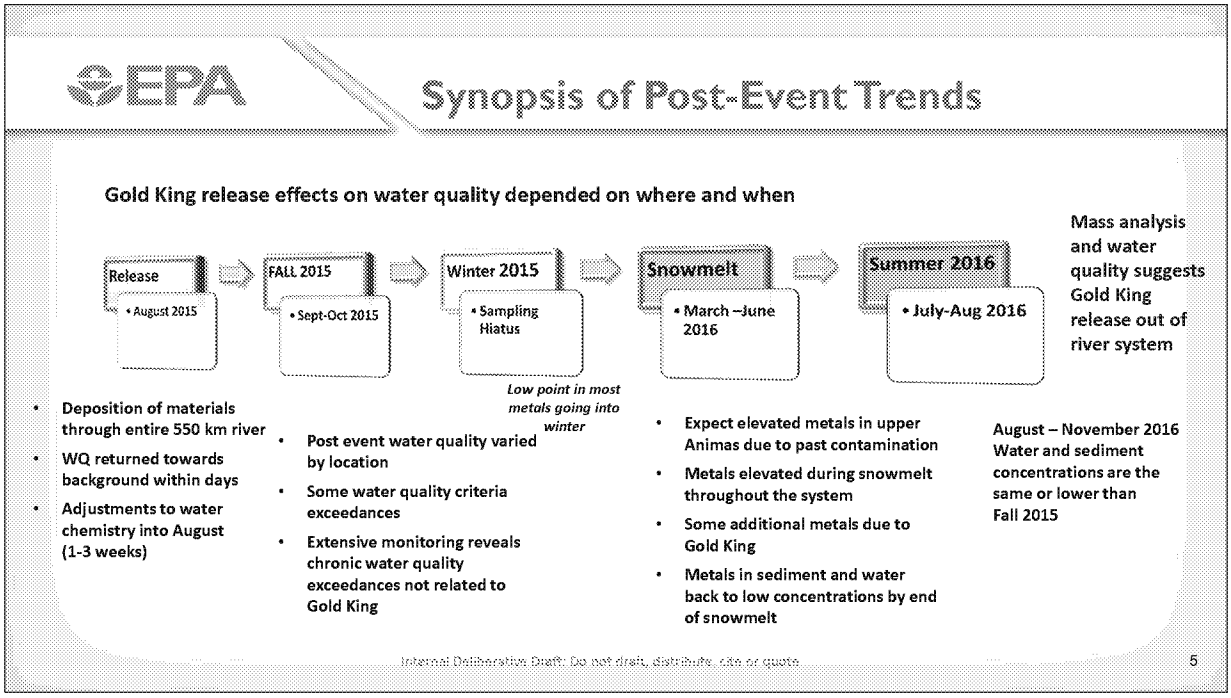
Key Findings—Gold King Release Post Event

- **ORD produced hydrologic and geochemical evaluations of the Gold King release during and for a year following the release**
- **Post event water quality response from August to October 2015 varied by location**
  - **Animas in Colorado returned to background**
  - **Animas in New Mexico and San Juan River had elevated metals above expected**
  - **Chronic exceedances of water quality criteria revealed by monitoring**
- **2016 snowmelt had elevated metals throughout the system—partly from Gold King, partly from historic mining impacts**
  - **Model results and analyses indicate GKM metals now out of rivers**
  - **2016 samples after snowmelt at pre-event levels**
  - **We have a "fingerprint" unique to identify metals of the Gold King release**
- **There were water quality exceedances during the plume and post event varying by location and state or tribe, some due to Gold King**
  - **E.g. aluminum, lead, copper, zinc, arsenic**
- **ORD findings will help inform EPA monitoring and reporting**

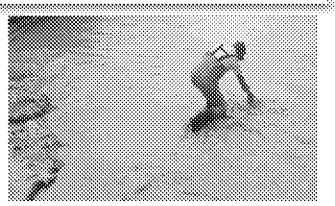


Animas at Bakers Bridge (above) and popular swimming beach north of Durango (right)
August 2016

Both areas experienced high settling rates during plume



Water and Sediments Monitored Since the Release



POST GOLD KING MONITORING

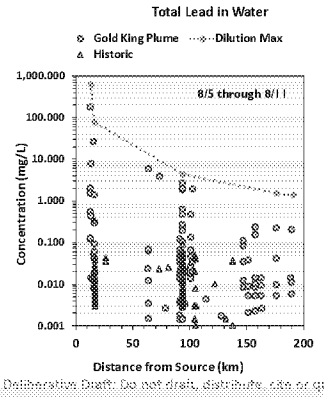
- **1,400 total and dissolved water samples through 8/27/2016**
- **820 sediment samples through 9/1/2016**
- **294 sites with 1 or more samples**

HISTORIC DATA

- **Hundreds of water samples**
- **30-50 sediment samples**

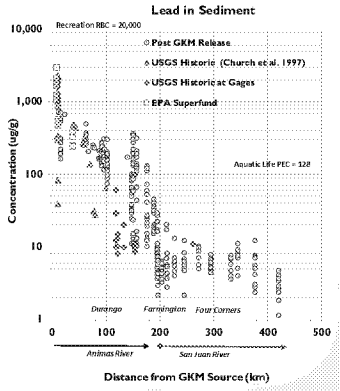
WATER:

--Concentrations decreased in water and sediment moving down river from the Gold King during plume



Sediment:

- Deposited metals reflect historic contamination
- No statistical change from historic



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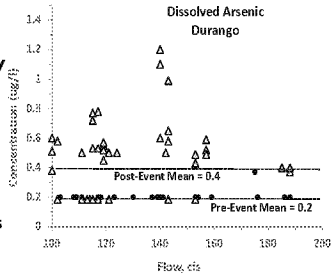
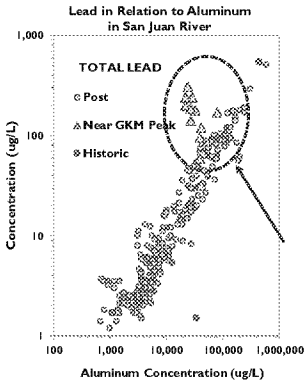
Methods Rationale

- Limited to locations where pre-event data existed
- Comparisons with pre-event limited by available historic data
- Significantly reduced number of post-event monitoring samples that could be used

Statistical comparisons between pre- and post-event samples



Correlation analysis between trace metals and aluminum or iron



- Relationship between trace metals and Aluminum or Iron is an indicator of expected background levels in sediments and water
- Used in project as a sensitive signature of the of Gold King metals
- Maximizes use of available data
- Even a limited amount of historic data is useful

Lead high for amount of background aluminum as Gold King plume passed through

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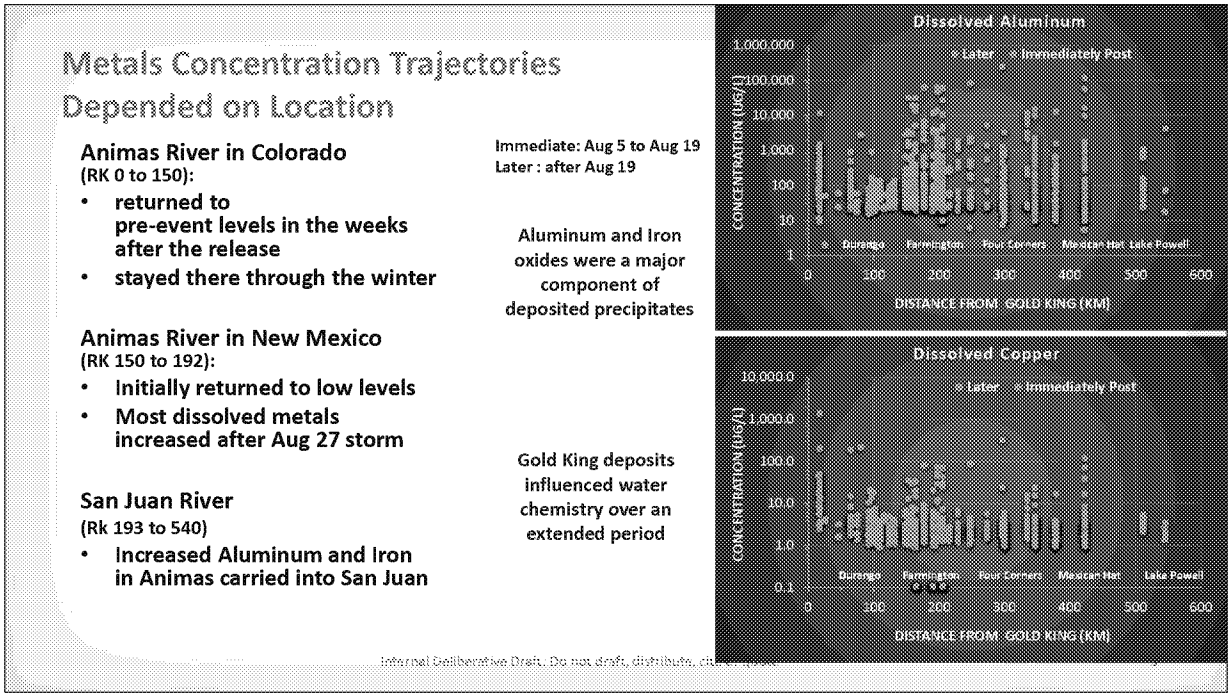

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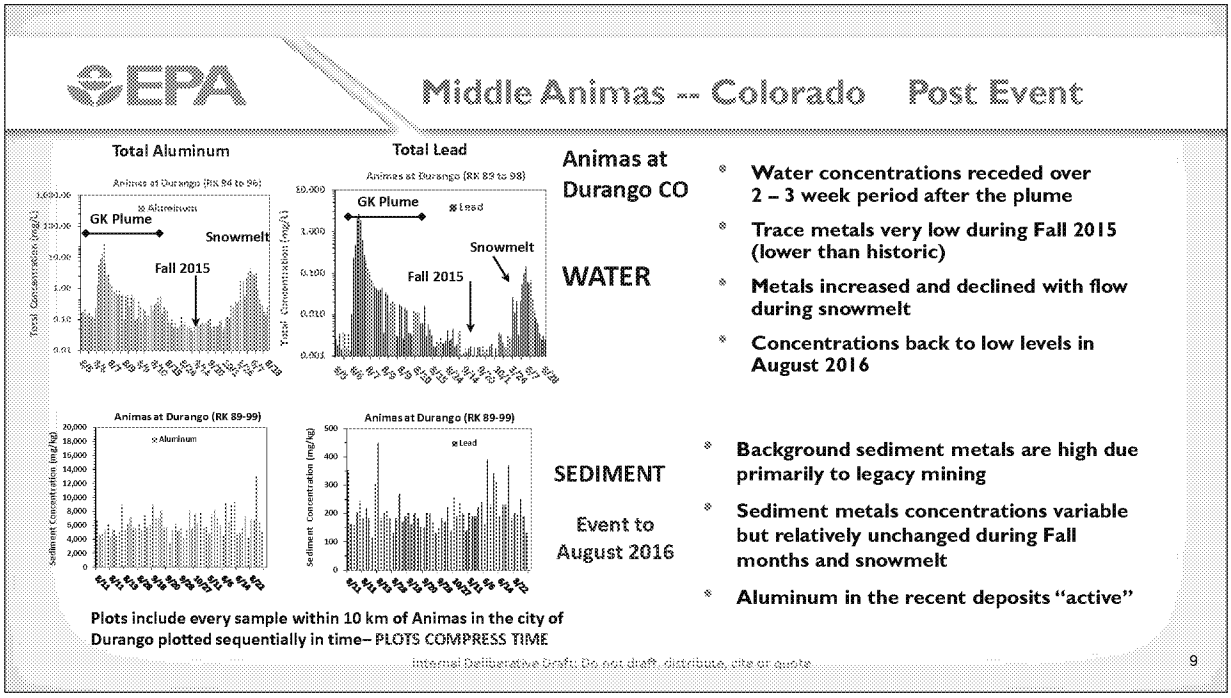

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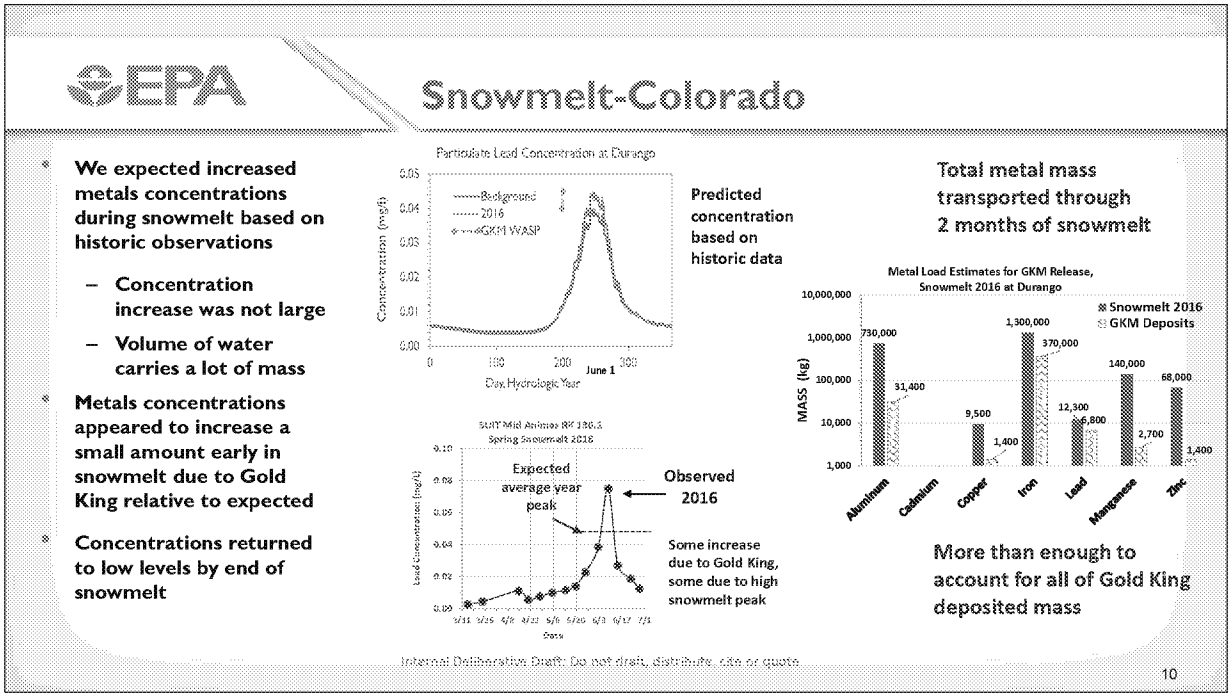

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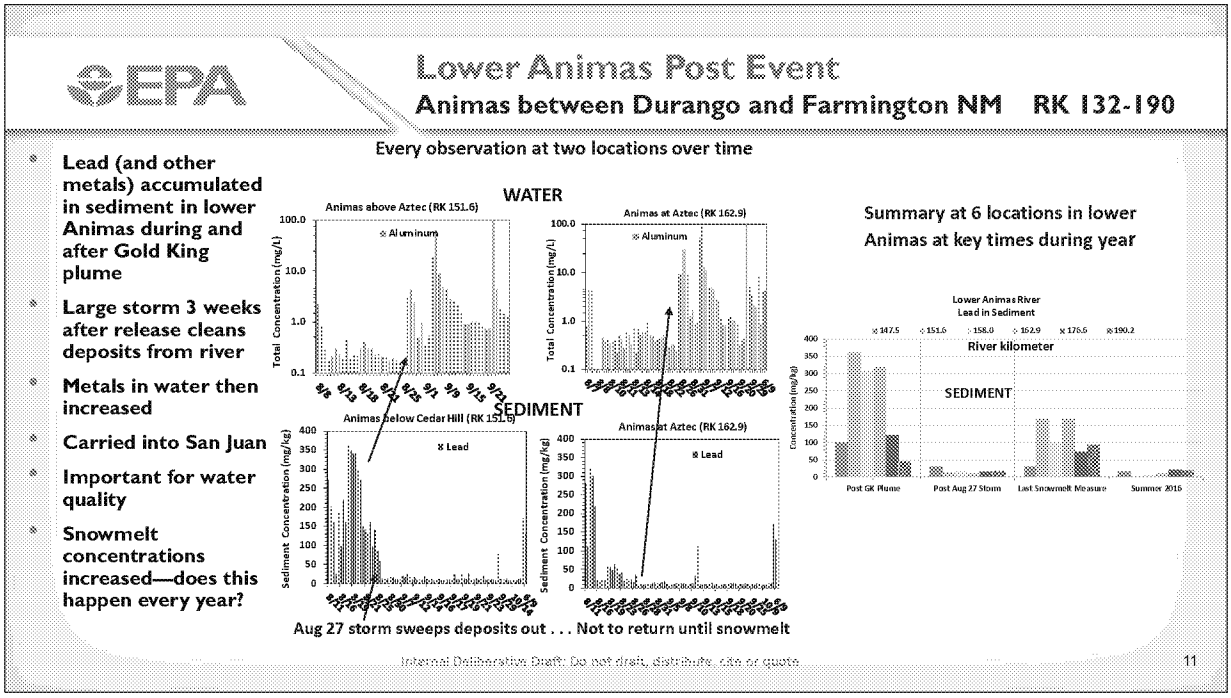

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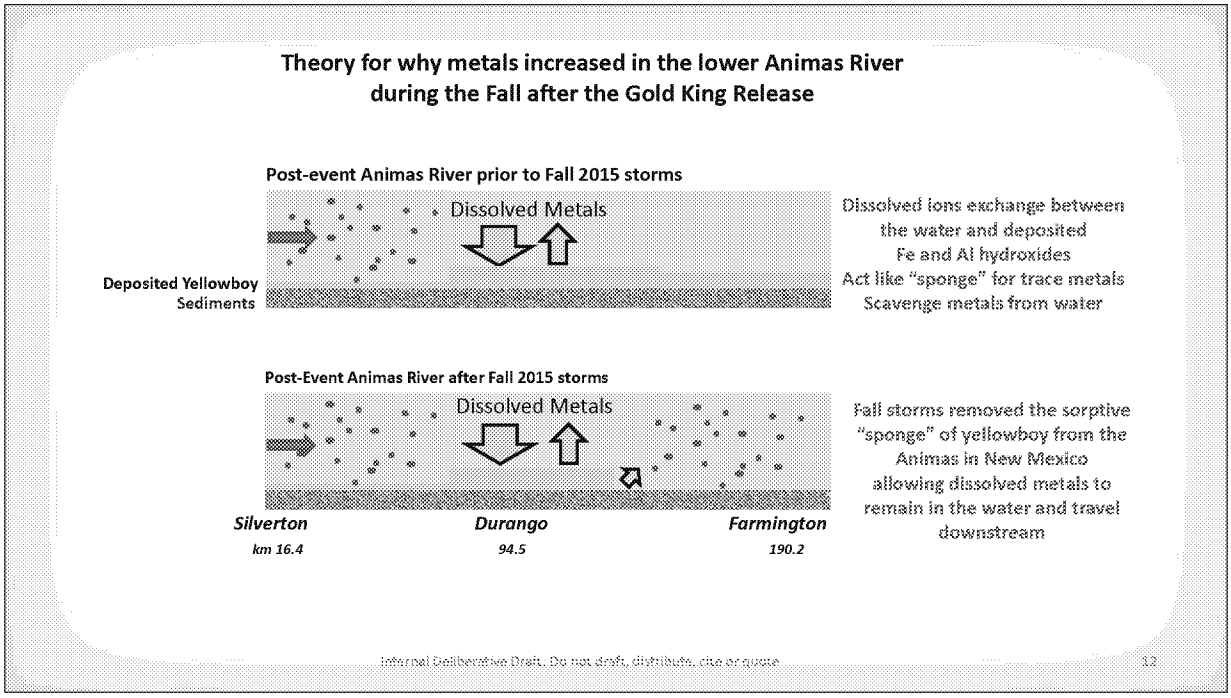

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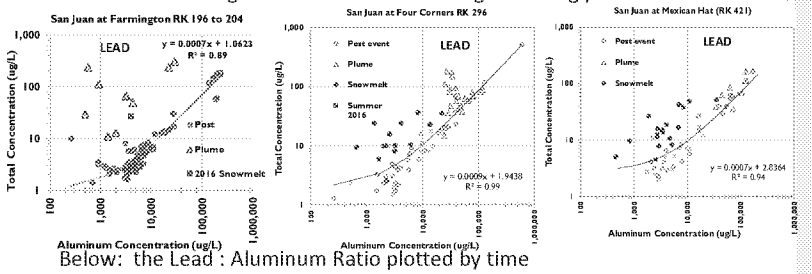
San Juan Post Event Water/Sediment

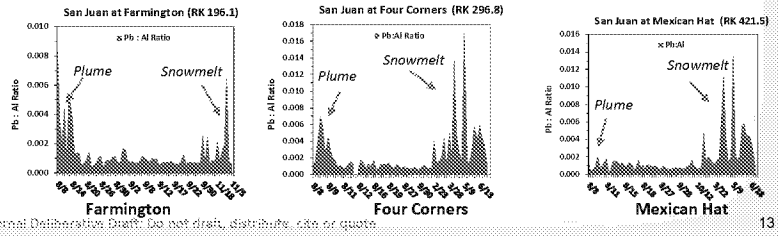
- **Concentrations of metals (lead) in San Juan River**
  - **Influenced by Animas near confluence in Farmington**
  - **Were elevated during plume--undetectable at lower reaches near Mexican Hat**
  - **Also elevated in water and sediment during snowmelt season**
  - **Lead main metal detected**

This correlation technique was powerful for identifying Gold King

Water Concentration --higher lead detectable during Gold King plume and snowmelt



Below: the Lead : Aluminum Ratio plotted by time



Has the System Returned to Pre-Event?

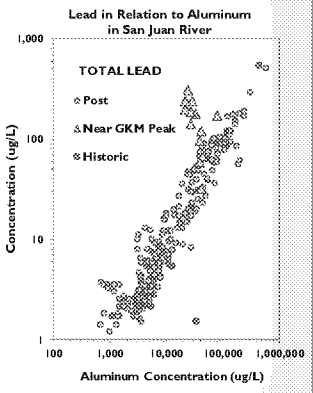
What Did Statistics Confirm About Post-Event Metals—Fall 2015?

Water

- Most metals significantly lower after Gold King in the middle Animas (Colorado)
- Elevated Iron and Aluminum in lower Animas after August storms (New Mexico)
- Elevated Iron and Aluminum in San Juan throughout the period (NM, UT, Navajo)

Sediment

- Despite large deposited mass, no significant increase in river sediments



What Remains to be Established?

Water

- We saw a Gold King signature far down the San Juan during snowmelt (RK 350km – Montezuma Creek). Will that reoccur in later years?
- Can we reliably establish baseline relationships between Aluminum and other metals as evidence to confirm the end of GKM influence in the system?

Sediment

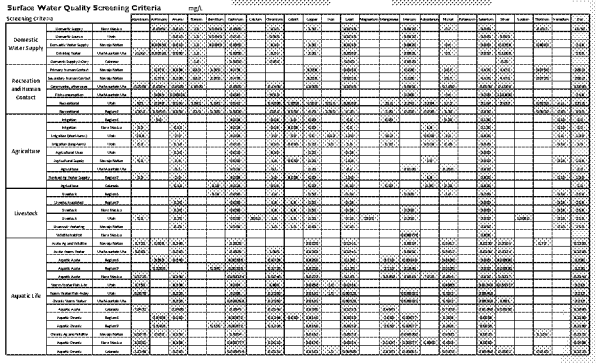
- We expect to see higher sediment mass moved during snowmelt every year in Colorado. Will we also see elevated metals during snowmelt in lower Animas and San Juan in 2016?

Are Changes to Water Quality Meaningful?

* **EPA Conceptual Monitoring Plan Implemented 2016**
  - **Proposes to answer this question by comparing observed concentrations to water quality criteria**
  - **To assist OW in doing this for 1st year monitoring results, we have done this screening**
* **About the Criteria**
  - **Multiple states and tribes located at different points along the river**
  - **Criteria address both total and dissolved fractions**
  - **Cover a wide range of concentrations depending on beneficial use**
  - **Many tribal criteria thresholds much lower than states**

24 metals x 40 criteria : 1400+ samples

Total **Dissolved**



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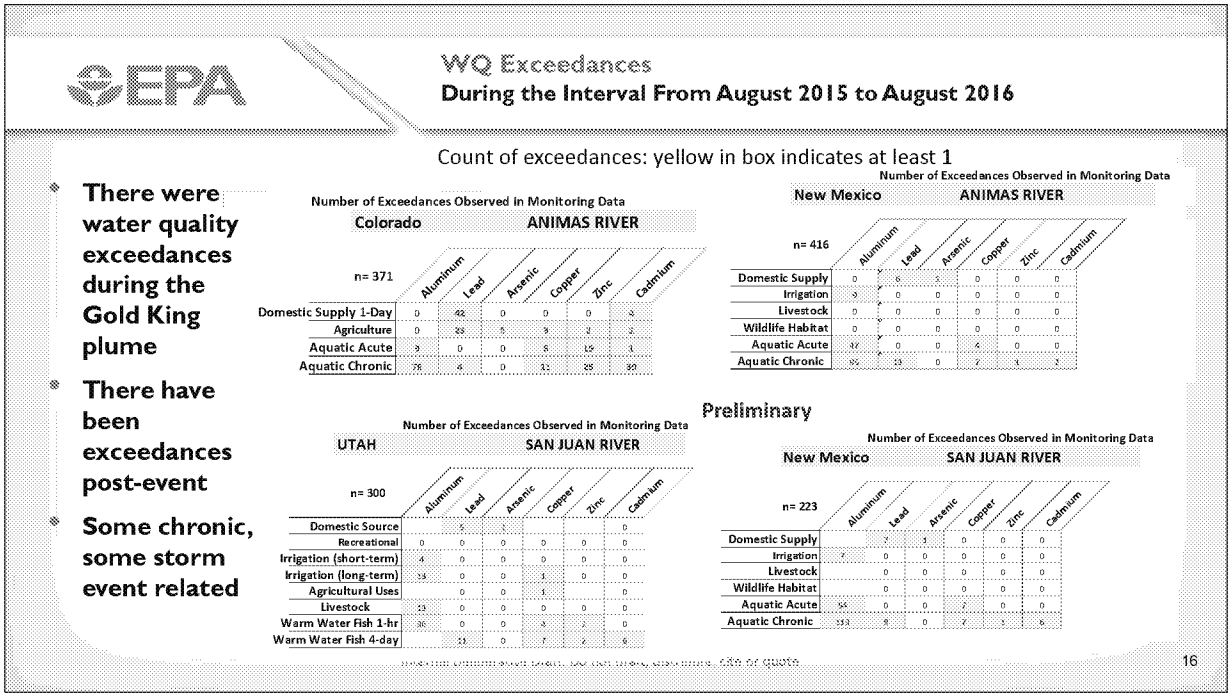

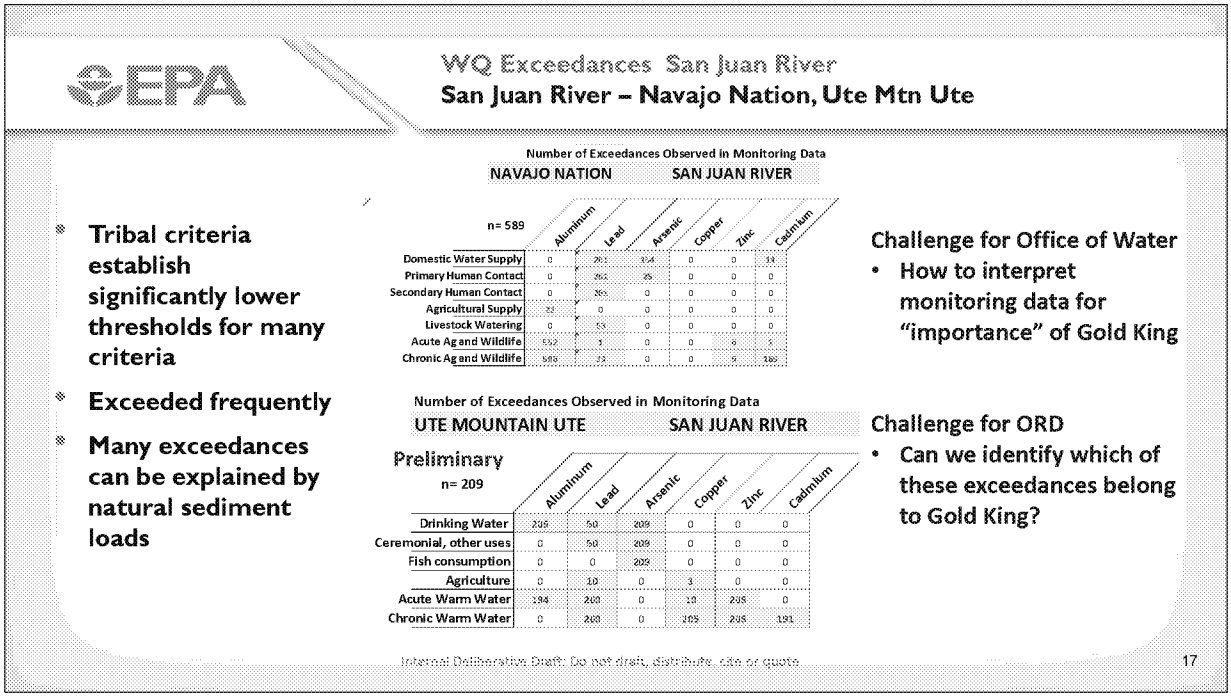

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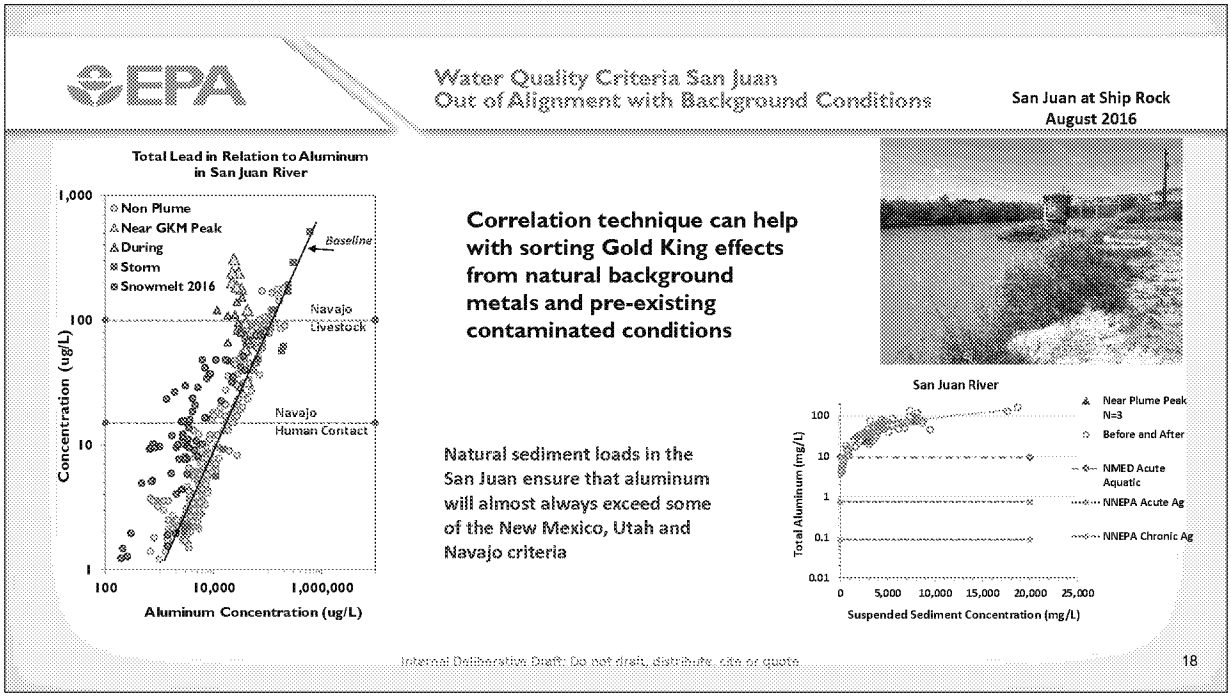

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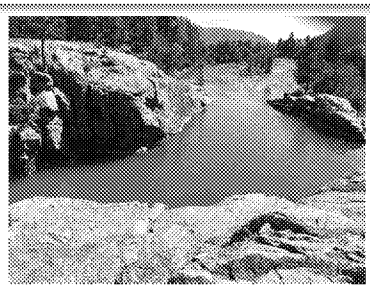

Next Steps:

- **Finalizing ORD Report**
- **Working with OWOW to have ORD report support EPA obligations for a 1st year monitoring report**
- **Evaluating monitoring needs going forward**
- **Publish findings**

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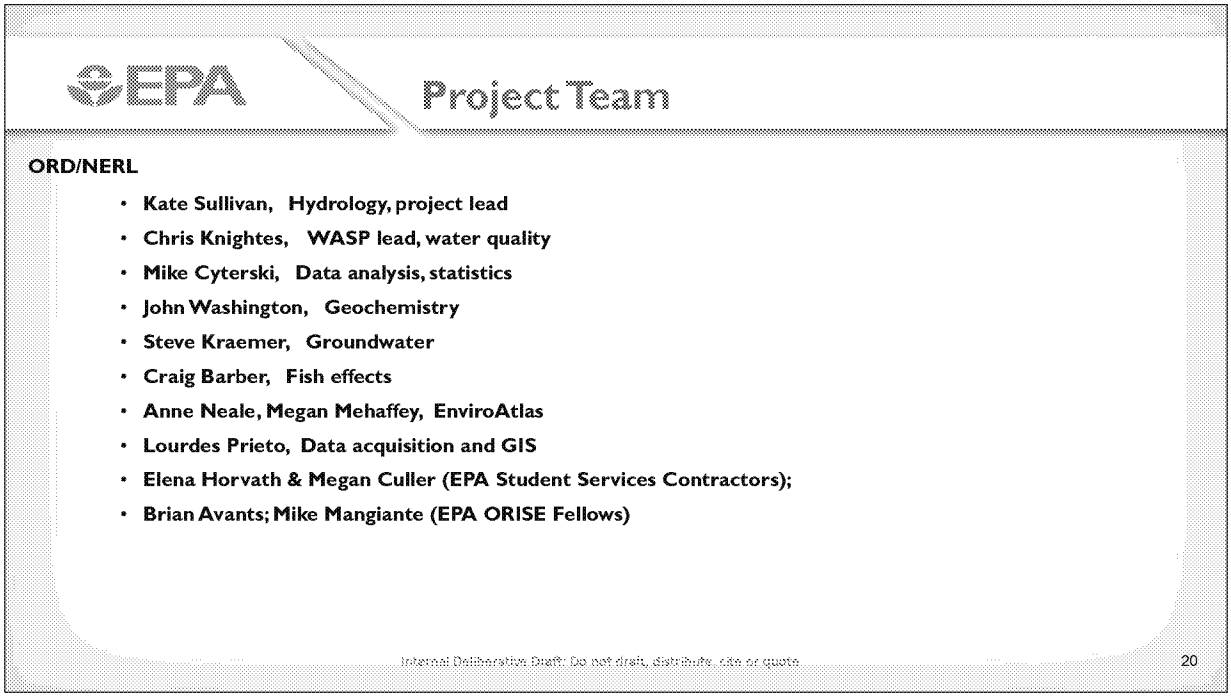

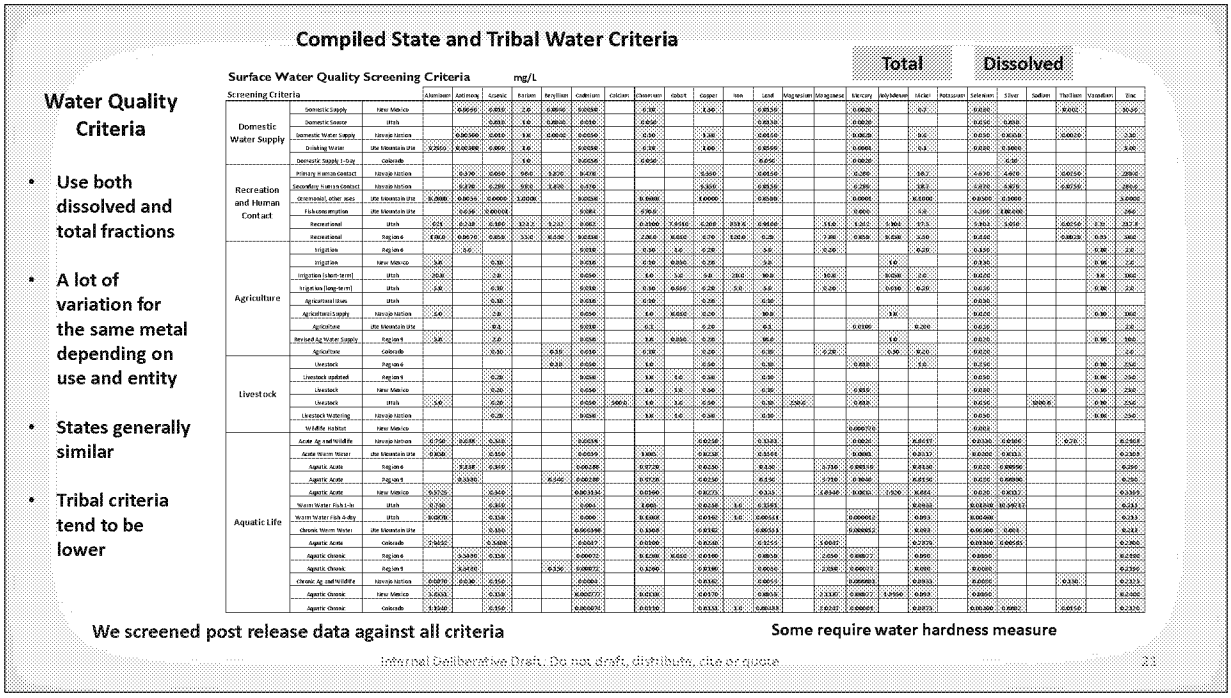

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